DOCUMENT RESUME

ED 167 810 SE 026 799

AUTHOR Lind, Jackie; Premo, Joe
TITLE Energy Education in Elementary Science: Science Curriculum Improvement Study.
INSTITUTION Minnesota State Energy Agency, St. Paul.
PUB DATE Oct 78
NOTE 93p.; For related document, see SE 026 798

EDRS PRICE MF-$0.83 HC-$4.67 Plus Postage.
DESCRIPTORS Biological Sciences; *Concept Teaching; *Curriculum Enrichment; *Elementary Education; *Energy; Physical Sciences; *Science Course Improvement Project; Science Education; Scientific Concepts
IDENTIFIERS *Energy Education; Minnesota

ABSTRACT

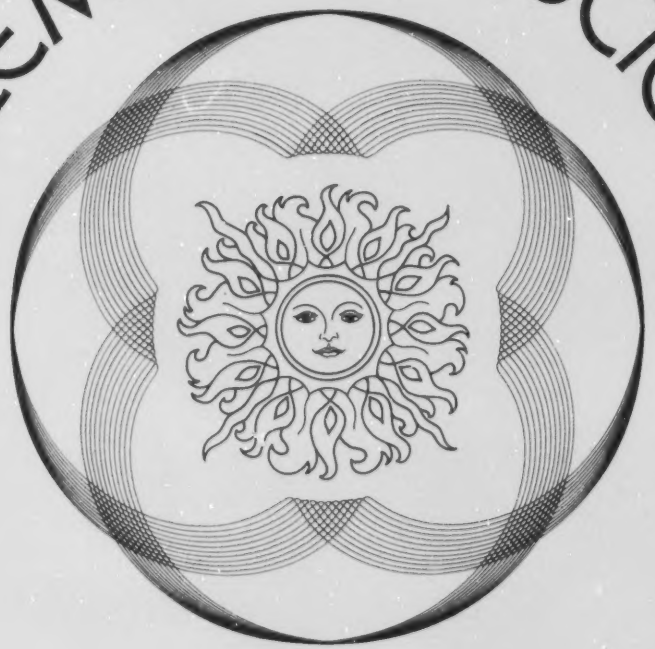
This looseleaf teacher's manual is designed to facilitate using Science Curriculum Improvement Study (SCIS) for energy education in elementary schools. It is intended to be used with the SCIS Teacher's Guide as a supplement. The format of this manual matches a main SCIS concept with a closely related energy concept. Matrices show matched concepts for each unit. Short elaborative paragraphs are given for each matched concept for the life science and physical science units to serve as teacher preparation. (Author/MR)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

SE026 799

ED167410

ENERGY EDUCATION IN ELEMENTARY SCIENCE



U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Jackie Lind

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

MINNESOTA ENERGY AGENCY – JANUARY 1979

980 American Center Building
150 East Kellogg Boulevard
St. Paul, Minn. 55101
(612) 296-5769

Science Curriculum Improvement Study

WRITERS

Jackie Lind, Information and Education Specialist
Minnesota Energy Agency

Joe Premo, Science Consultant
Minneapolis Public Schools

The financial support of the Minnesota Energy Agency is acknowledged, but the authors assume complete responsibility for the contents herein.

October, 1978

Minnesota Energy Agency
980 American Center Building
150 East Kellogg Boulevard
St. Paul, Minnesota 55101

CONTENTS

1. Introduction

2. Outline of Energy Education Topics

3. Energy Concepts for Elementary Education

4. Energy - SCIS Matrix for Kindergarten (Beginnings)

5. SCIS Life Science Concepts

6. Energy - SCIS Matrix for Life Sciences

7. Life Science Units

    Organisms - Year 1
    Life Cycles - Year 2
    Populations - Year 3
    Environments - Year 4
    Communities - Year 5
    Ecosystems - Year 6

8. SCIS Physical Science Concepts

9. Energy - SCIS Matrix for Physical Sciences

10. Physical Science Units

    Material Objects - Year 1
    Interaction and Systems - Year 2
    Subsystems and Variables - Year 3
    Relative Position and Motion - Year 4
    Energy Sources - Year 5
    Models: Electric and Magnetic Interactions - Year 6

INTRODUCTION

The Science Curriculum Improvement Study (SCIS)* can make a contribution to energy education. This manual identifies those contributions. The reason for writing this manual is based on the following statements:

1.) Many energy concepts can be taught with existing curriculum materials that teachers are using in their classrooms.

2.) The SCIS units include energy concepts as well as physical and life science concepts.

3.) A teacher who is aware of how and where energy concepts coincide with the SCIS concepts will be better prepared to teach about energy as appropriate classroom situations occur.

4.) Increased teacher awareness of energy concepts will result in increased student involvement with energy information.

Therefore, this manual is written to the teacher. It identifies the contributions SCIS makes to energy education. It is intended to be used with the SCIS Teacher's Guide in a supplementary role. The loose-leaf format will permit individual pages to be inserted in appropriate Teacher's Guides.

The format is structured so that a main concept from SCIS is matched with a closely related energy concept. A matrix helps the teacher identify at a glance which concepts are matched for each unit. Only the SCIS content areas are specifically mentioned here since the equally important scientific processes are the same for both SCIS and energy.

A short paragraph for each set of matched concepts elaborates on how a particular SCIS activity fits into the overall scheme of energy education. It briefly explains the relationship between an activity and the goal of energy literacy. In most cases, the paragraphs are intended as teacher background information and can help a teacher in preparing for a SCIS activity.

*Science Curriculum Improvement Study; The Regents of the University of California, 1974. Published by Rand McNally and Company.

OUTLINE OF ENERGY EDUCATION TOPICS

(Used as the basis for the analysis of the SCIS program)

I. BASIC ENERGY INFORMATION

- A. Definition - Properties
- B. Sources - Renewable and non-renewable
- C. Forms: chemical, mechanical, radiant, nuclear, electrical
- D. Uses: residential, commercial, industrial (agriculture, food processing, mining, manufacturing), transportation, utility generation
- E. Conversion Systems/Technologies
- F. Ways of Conserving Energy

II. SOCIETY'S DEPENDENCE ON ENERGY

- A. Demands/needs related to resources (end-use) and life style
- B. Effects upon economy and economic system
- C. Effects on Political Relationships: local, national, international
- D. Values

III. POSSIBLE SOLUTIONS - PROBLEMS AND ADVANTAGES OF ENERGY ALTERNATIVES

- A. Alternative sources (types, uses, supply, time-lag) (values: cost, change in life style, trade-offs)
- B. Conservation (types, uses, supply, time-lag) (values: cost, change in life style, trade-offs)

IV. MINNESOTA'S ENERGY ISSUES

- A. Location, climate
- B. Sources available
- C. Problems with sources
- D. Ownership
- E. Control and effect of government policies and regulations
- F. Transportation
- G. Values

ENERGY CONCEPTS FOR ELEMENTARY EDUCATION*

Background Material for Teachers

DEFINITIONS

1. Energy is the capacity to do work or make something move. The "go" of things.

   A. Power is the rate that energy is produced or used.
   B. Efficiency is the amount of work done in proportion to the energy used.
   C. Work is done when an object is moved.
   D. Force is required to produce an acceleration in the motion of a body.

2. Energy is a resource.

3. Energy is the ability to cause change.

SOURCES: WHERE DOES ENERGY COME FROM?

1. Primary Sources

   Primary sources are sources naturally available on the earth.

   A. Renewable Sources are recurring or continuous.

      1. The sun is the main source of energy.
      2. Other renewable sources of energy are: geothermal, wind, hydro, tidal, and organic material.

         Although they are available, the following sources are little used and need further development.

         a. Wind power
         b. Solar power
         c. Tides
         d. Geothermal
         e. Organic Wastes
         f. Peat (through some processes of recovery)

   B. Non-renewable Sources are sources that take a great deal of time to form and cannot be replenished in human time spans.

*From Energy Task Force, Minnesota Department of Education

1. Some non-renewable sources are fossil fuels: coal, oil, natural gas, and peat.

   a. Currently most of our usable energy comes from fossil fuels.
   b. Fossil fuels are non-renewable resources in limited supply.
   c. No one knows exactly how much fossil fuel remains. Estimates depend on finding out where they are available, how easy it would be to recover them, and the cost of this recovery.
   d. Some fossil fuels are in difficult places for recovery (e.g., oil, shale, tar sands, liquid natural gas and liquid petroleum gas.)

2. Another non-renewable source is uranium used in nuclear fission reactors.

2. Secondary Sources

Secondary sources of energy are products of human technology.

A. Electricity is a secondary source of energy. Primary sources of energy are used to make it.

B. Some other secondary sources of energy are: solid wastes, fuel cells and the conversion of chemical energy.

3. Differences Among Energy Sources:

A. Some work only under certain conditions or are practical only under certain conditions.
B. Some work only in certain places.
C. Some take much time to form.
D. Some are slower and less efficient.
E. Some take less time to convert.
F. Some need technology to be converted to usable forms.

STATES

The basic states of energy are energy at rest and energy at work.

1. Kinetic energy is energy at work; the product of force and movement. (Examples: machines at work, persons at work, burning fuel.)

2. Stored or potential energy is energy at rest which can be made active. (Examples: nuclear energy, fossil fuels, a boulder on top of a hill, a battery, or water behind a dam.)

STORAGE

1. Potential energy is stored energy.

A. Fossil fuels are stored chemical energy and are made active by combustion.
B. Nuclear energy is stored energy in the atom.

2. Solar, tidal and geothermal energy are sources of energy flows; ways must be found to store them.

FORM: HOW CAN ENERGY BE SEEN AND FELT?

1. Energy can take many forms.

   A. Energy can be detected in the following forms: heat, light, motion.
   B. Energy can take the following forms: thermal, radiant, chemical, mechanical, sound and nuclear.

2. Energy can be measured (e.g., temperature measurement, measuring the change of position, reading meters such as gas meters, ohm meters, and volt meters).

ENERGY CONVERSION: WHERE DOES ENERGY GO?

1. Energy can be converted from one form to another.

2. Once energy is used, it cannot be used again in that form. (Note: This is a beginning level for the understanding that energy is neither created nor destroyed.)

3. In changing energy from one form to another, some energy is lost.

4. As energy is used, it produces by-products (such as heat) which may be recycled or which may be unavailable for us.

ENERGY TRANSFER

Energy is transferred by convection, radiation and conduction.

TRANSPORTATION OF ENERGY

Energy sources are transported by pipe or pipeline, radiation, ship or barge, wire or line, truck and train.

HOW IS ENERGY USED?

BASIC USES

1. Energy is needed to do work and to live.

2. Nothing acts, nothing moves without energy.

3. Energy drives the muscles of human beings.

4. Machines use energy to make things.

   A. Some machines are more efficient than others.

5. Machines use energy to change energy from one form to another (e.g., chemical to mechanical)

6. Machines use energy to change potential energy to kinetic energy.

7. Energy must be spent to get energy we can use.

8. Energy is used in our daily living to make our clothes, food, paper, and to move us from place to place in cars and busses.

PERSONAL/SOCIAL USES

1. As individuals we are personally dependent upon energy.

2. Individuals and groups have responsibility for energy conservation and use.

3. Energy can be conserved by developing energy saving habits.

4. Societal actions and values extend or exhaust available supplies of energy.

   A. Past and present use of energy resources precipitated and accelerated the energy problem.
   B. In order to impact on the energy problem, old habits must be changed.

5. Population changes directly influence energy use, availability and supply.

NATIONAL USES

1. Industry

   Industry uses much of our country's energy.

   A. About forty percent of all energy is used by industry.
   B. Industry uses energy for heating, electricity, running machinery, electrolytic processes, processing raw materials, and maintaining a plant or office.
   C. The following industries are high users of energy: food processing, oil pumping and refining, steel and aluminum manufacturing, paper manufacturing, glass/clay/stone products, and chemical industries.

2. Transportation

Energy is used for transportation.

A. Transportation requires 25 percent of our country's energy.
B. Automobiles account for more than half of the energy used for transportation.
C. Trucks, airplanes, and trains also use energy.

3. Residential

Homes use energy for heating, cooling, lighting and appliance use.

A. Twenty percent of the country's energy is used for residences.
B. Homes use the highest amounts of energy for heating, water heating, refrigeration and cooking.

4. Commercial

Energy is used for commercial places such as offices, businesses, hotels, schools, hospitals and restaurants.

MINNESOTA USE

Minnesota's use of energy is different from the national picture.

1. Minnesota has limited non-renewable energy sources.

2. Minnesota depends upon energy sources from outside the state.

3. Minnesota has special problems of transmission and transportation of energy resources.

4. Minnesota has a long heating season requiring greater residential use of energy.

5. Minnesota has special problems with:

CONSERVATION

1. Consumption of fossil fuels has been increasing faster than the rise in population during the past 30 years. The demand will increase.

2. We must conserve the non-renewable fuels that are left.

3. Major energy users must become big energy savers.

4. Energy conservation buys time to develop new alternative sources.

5. Some ways that major energy savings can be practiced are: Industry - building design and industrial operating changes, recycling and increased energy transmission efficiency; Transportation - mass transit and use of smaller automobiles; Residential - use of more efficient appliances, recycling and improved home insulation.

6. People must identify, examine and clarify their own values and behave in a way that is consistent with those values.

WHAT ARE THE CONSEQUENCES OF ENERGY USE?

TRADE OFFS

1. Economic, ecological, aesthetic, political and social trade-offs are involved when decisions are made regarding the use of energy resources.

2. Energy-environment decisions require making value judgments of the trade-offs involved. A decision involves the acceptance of the possible disadvantages of the choice along with the advantages.

3. As we use up our non-renewable resources and have a hard time paying for foreign fuels, there will be more governmental action, voluntary conservation, market place restructuring or a combination of these.

ECONOMIC CONSEQUENCES

1. Supply

   A. We are consuming our energy sources faster than we are able to bring alternatives into practicality.
   B. New sources of energy must be identified and developed.
   C. U.S. oil and natural gas supplies will be depleted in about 100 years even if there is not an increase in our present rates of consumption.
   D. U.S. oil and gas production does not meet our nation's needs. Oil imports are increasing each year.
   E. Historically, there has been from three to five decades between the first speculation into new sources of energy and their commercial feasibility.

2. Cost

   A. As energy is used or conserved, there is a direct impact on economic systems.
   B. Future energy systems will demand extensive capital.
   C. High costs of new energy sources limit their use.

3. Cost/Supply Interaction

   A. Shortage of a material such as oil occurs when, at a given price, the demand exceeds the supply.

B. Energy scarcity requires that growing economies make a vastly larger capital investment and/or reduce their energy demands.

ENVIRONMENTAL CONSEQUENCES

1. As energy is used or conserved, there is a direct impact on our environment.

2. Energy production affects our surroundings.

3. Sources of energy that we use differ in their environmental effects.

4. A concern for the environmental consequences of energy use may require additional energy and also may demand additional money.

LIFE STYLE CONSEQUENCES

1. The relationship between energy sources, consumption and life styles must be examined.

   A. Energy use has an impact on family economics.
   B. Energy conservation has an impact on family life style.

2. Changes of energy use results in the creation of some jobs and the loss of others.

3. New or modified perceptions of living and working styles will be needed to deal with the energy problem.

POLITICAL CONSEQUENCES

1. The necessity to import oil influences U.S./foreign policies.

2. Environmental and economic effects of energy development and use affect relationships between people in regions of this country and the world.

3. If the energy problems reach a crisis stage, there will be more governmental action in the distribution and consumption of energy resources.

4. Our present energy practices will affect alternatives of societies in the future.

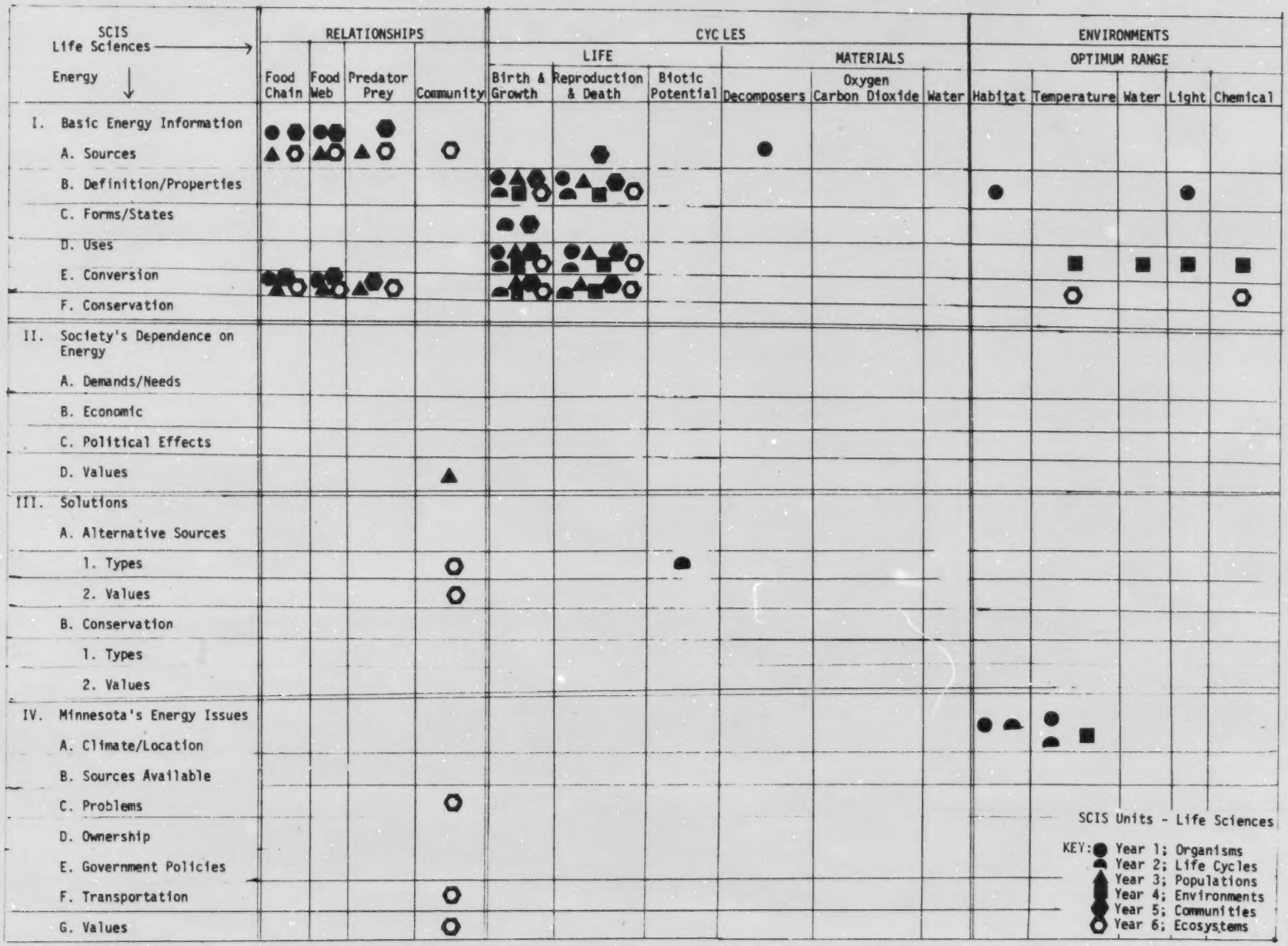
Energy - SCIS Matrix for Kindergarten (Beginnings)

	Color	Shape	Texture	Odor	Sound	Size	Quantity	Position	Organisms
I. Basic Energy Information A. Sources					*				
B. Definition/Properties									*
C. Forms/States	*				*				
D. Uses					*				*
E. Conversion									
F. Conservation									
II. Society's Dependence on Energy									
III. Possible Solutions									
IV. Minnesota Energy Issues									

Energy Concepts in SCIS Unit: Beginnings (K)

*SCIS Concept: Color Energy Concept: Forms of Energy (light) Beginnings Chapters: 1-10	Most activities in the Kindergarten unit deal with energy indirectly. However, this does not lessen the importance of their contribution to energy literacy. The activites on color are concerned indirectly with light energy, but provide necessary background for later studies on the composition of light. The color masks in Chapter 8 provide a first step in understanding the relationship between color and light.
*SCIS Concept: Sound Energy Concepts: Forms of Energy (sound); Sources of Energy; Uses of Energy Beginnings Chapters: 30-33	Students will experience sound energy through these activities, although they will probably not be discussing it in energy terms. Several devices (blindfolds, closed boxes) help the children isolate sounds by blocking out other stimulations around them. Energy sources supply energy when they interact with other systems. The students will be identifying energy sources when they discuss how sounds are produced. When they mention hitting, rubbing, plucking and blowing they are talking about interactions involving energy while using terms appropriate for this age group. In later SCIS units these experiences will be labeled as "interactions." These exposures to sound energy are also preparatory to a later concept of energy conversion systems or technologies. Students working with the tape recorder may begin questioning how sound can come from a machine. The concept that energy can be changed from one form to another (such as electrical energy to sound energy) has its beginnings here.
*SCIS Concept: Organism Energy Concept: Definition/Properties of Energy Beginnings Chapters: 51-65	The focus of these units is on the growth and development of plants and animals. In later units students will be defining energy as the ability of systems (including organisms) to bring about changes in themselves or in their environment. In these activities students can observe the changes in organisms as they grow and reproduce, thus observing a working definition of energy. A seed is an example of stored or potential energy. When the seed interacts with the right environmental conditions (particularly moisture), the stored energy is released. Students will observe the changes in the seed as it uses stored energy and germinates.
*SCIS Concept: Organism Energy Concept: Uses of Energy Beginnings Chapters: 51-65	Some of the unit activities may trigger discussions about the things plants and animals need in order to live, grow and reproduce. Students will be concerned that their organisms have light, food and water, and the right temperature. Plants and animals use light energy, heat energy and chemical energy (from food) for growth and reproduction.

ENERGY - SCIS MATRIX FOR LIFE SCIENCES



SCIS Life Sciences Concepts

CONCEPTS	SCIS Units					
	ORGANISMS Year 1	LIFE CYCLES Year 2	POPULATIONS Year 3	ENVIRONMENTS Year 4	COMMUNITIES Year 5	ECOSYSTEMS Year 6
RELATIONSHIPS						
Food Chain	●		▲		⬢	⬡
Food Web	●		▲		⬢	⬡
Predator-Prey			▲		⬢	⬡
Community			▲		⬢	⬡
CYCLES						
Life						
Birth & Growth	●	◗	▲	■	⬢	⬡
Reproduction & Death	●	◗	▲	■	⬢	⬡
Biotic Potential		◗				
Materials						
Decomposers					⬢	⬡
Oxygen-Carbon Dioxide						⬡
Water						⬡
ENVIRONMENT						
Habitat	●		▲	■		⬡
Optimum Range						
Temperature				■	⬢	⬡
Water				■		⬡
Light				■		⬡
Chemical				■		⬡

ENERGY - SCIS MATRIX FOR LIFE SCIENCES
Year 1; Organisms

	RELATIONSHIPS				CYCLES						ENVIRONMENTS				
					LIFE			MATERIALS			OPTIMUM RANGE				
	Food Chain	Food Web	Predator Prey	Community	Birth & Growth	Reproduction & Death	Biotic Potential	Decomposers	Oxygen Carbon Dioxide	Water	Habitat	Temperature	Water	Light	Chemical
I. Basic Energy Information															
A. Sources	●	●						●							
B. Definition/Properties					●	●					●			●	
C. Forms/States															
D. Uses					●	●									
E. Conversion	●	●													
F. Conservation															
II. Society's Dependence on Energy															
A. Demands/Needs															
B. Economic															
C. Political Effects															
D. Values															
III. Solutions															
A. Alternative Sources															
1. Types															
2. Values															
B. Conservation															
1. Types															
2. Values															
IV. Minnesota's Energy Issues															
A. Climate/Location											●	●			
B. Sources Available															
C. Problems															
D. Ownership															
E. Government Policies															
F. Transportation															
G. Values															

Energy Concepts in SCIS Unit: Organisms (Year 1)

*SCIS Concept: Food Chain, Food Web Energy Concept: Sources of Energy Organisms Chapters: 12-13	Students will be observing that the Daphnia eat the algae, and the guppies eat the Daphnia. Another way for the students to discuss this food chain is to say that the Daphnia get their energy by eating the algae; the guppies get their energy by eating the Daphnia. In this way the living materials will be seen as sources of energy.
*SCIS Concept: Decomposers Energy Concept: Sources of Energy Organisms Chapters: 6, 15	The death of a fish in the aquarium and the use of detritus to grow mustard seeds are both indirectly involved as energy sources. Students may observe that the dead fish "disappears." It is being used as an energy source for other living things in the aquarium. Although the students will not understand the complex role of decomposers, they will see the changes that result from this involvement of energy. The "black stuff," or detritus, will be used as an energy source for the growth of mustard seeds. Once again, students can see the effects of this energy involvement without having to understand at this time the process of decomposition.
*SCIS Concept: Birth, Growth & Reproduction Energy Concept: Definition/Properties of Energy Organisms Chapter: 3	Students will be observing the organisms in their aquaria as they move, grow, and give birth. Energy is the ability to cause these changes in the organisms. Students will be observing an operational definition of energy.
*SCIS Concept: Habitat (Light) Energy Concept: Definition/Properties of Energy Organisms Chapter: 2	The students' plant may start bending toward the light. Students will be observing that a property of light energy is the ability to cause this change in their plants.
*SCIS Concepts: Growth, Reproduction Energy Concept: Uses of Energy Organisms Chapter: 9	Students will observe and experiment with the photosynthesis process. Light energy is used to convert minerals, water and carbon dioxide to food for the algae. The use of light energy will be seen as the water turns greener from increased algae growth.
*SCIS Concepts: Food Chain, Food Web Energy Concept: Conversion Systems Organisms Chapters: 12-13	Energy is converted from one form to another through the food chains. When the Daphnia eats the algae, chemical energy from the algae is converted to mechanical energy. We see the results of this conversion as the Daphnia moves and swims. The Daphnia's body (as well as the guppy's body) can be thought of as an energy conversion system.

SCIS Unit: Organisms (Year 1) Continued

*SCIS Concept: Habitat (Temperature) Energy Concept: Minnesota's Climate Organisms Chapters: 7-8	Any organism's particular environment is its habitat. Include Minnesotans as well as guppies, snails, and plants during the application stage of the habitat concept. Students can consider what their habitat is like where they live; what do they need to be comfortable? Focus on the extreme hot and cold temperatures in Minnesota, and consequently the high energy needs for heating and air conditioning.

ENERGY - SCIS MATRIX FOR LIFE SCIENCES
Year 2; Life Cycles

	RELATIONSHIPS				CYCLES						ENVIRONMENTS				
					LIFE			MATERIALS			OPTIMUM RANGE				
	Food Chain	Food Web	Predator Prey	Community	Birth & Growth	Reproduction & Death	Biotic Potential	Decomposers	Oxygen Carbon Dioxide	Water	Habitat	Temperature	Water	Light	Chemical
I. Basic Energy Information															
A. Sources															
B. Definition/Properties					●	●									
C. Forms/States					●										
D. Uses					●	●									
E. Conversion					●	●									
F. Conservation															
II. Society's Dependence on Energy															
A. Demands/Needs															
B. Economic															
C. Political Effects															
D. Values															
III. Solutions															
A. Alternative Sources															
1. Types							●								
2. Values															
B. Conservation															
1. Types															
2. Values															
IV. Minnesota's Energy Issues											●	●			
A. Climate/Location															
B. Sources Available															
C. Problems															
D. Ownership															
E. Government Policies															
F. Transportation															
G. Values															

Energy Concepts in SCIS Unit: Life Cycles (Year 2)

*SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Definition/Properties of Energy Life Cycles Chapters: 4-8	Energy is defined as the ability to cause change. It is the capacity to do work or make something move. The plants and animals in this unit provide students with an operational definition of energy as they grow, move, change and reproduce. The activities with pulleys in the second year SCIS Physical Science unit "Interaction and Systems" provide clearer examples of the energy of motion. A pulley system illustrates energy in a way that may be easier for primary students to understand. Relating the concept of energy of motion to plants and animals could follow these physical science activities.
*SCIS Concepts: Birth and Growth (Germination) Energy Concept: States of Energy Life Cycles Chapters: 1-3	A seed is an example of stored or potential energy. Given correct temperature and water, the germination process allows the seed to release its stored energy. This release of energy happens before photosynthesis begins. Students will see the effects of the seeds' stored energy being released as they observe the first appearances of roots and stems, and the withering of the seeds and cotyledons.
*SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Uses of Energy Life Cycles Chapters: 4-5	Students will discover the use of light energy for growth as they observe and experiment with their growing plants.
*SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Energy Conversion Systems Life Cycles Chapters: 4-5	Energy can be converted from one form (such as light or chemical) to another form (such as motion). Plants and animals can be thought of as systems in which this energy conversion takes place. Students will see the results of this energy conversion as their organisms take in light energy and food (chemical energy) and display energy of motion.
*SCIS Concept: Biotic-Potential Energy Concept: Alternative Sources of Energy (Biomass) Life Cycles Chapters: 9-10	Biomass is material from recent photosynthesis including agricultural crops and residues, timber, wetland plants, animal manures, and organic parts of solid waste. The success of biomass as an alternative fuel source is partly based on the biotic potential of the plant source. If cattails or water lillies are to become feasible sources of energy, they must have an enormous capacity to reproduce. Students who begin to understand biotic potential through the organisms in this unit will be better prepared to understand biomass as an energy source.
*SCIS Concept: Habitat (Temperature) Energy Concept: Minnesota Energy Issues - Climate Life Cycles Chapters: 4-5	Some students may have problems with plants and animals surviving in a winter classroom in Minnesota. Rather than discontinuing the unit if living materials die after a cold weekend, use the situation to discuss the heating problem - and thus increased energy needs - for a Minnesota classroom as compared to a classroom in California or Florida.

ENERGY - SCIS MATRIX FOR LIFE SCIENCES
Year 3; Populations

	RELATIONSHIPS				CYCLES						ENVIRONMENTS				
					LIFE			MATERIALS			OPTIMUM RANGE				
	Food Chain	Food Web	Predator Prey	Community	Birth & Growth	Reproduction & Death	Biotic Potential	Decomposers	Oxygen Carbon Dioxide	Water	Habitat	Temperature	Water	Light	Chemical
I. Basic Energy Information															
A. Sources	▲	▲	▲												
B. Definition/Properties					▲	▲									
C. Forms/States															
D. Uses					▲	▲									
E. Conversion	▲	▲	▲		▲	▲									
F. Conservation															
II. Society's Dependence on Energy															
A. Demands/Needs															
B. Economic															
C. Political Effects															
D. Values				▲											
III. Solutions															
A. Alternative Sources															
1. Types															
2. Values															
B. Conservation															
1. Types															
2. Values															
IV. Minnesota's Energy Issues															
A. Climate/Location															
B. Sources Available															
C. Problems															
D. Ownership															
E. Government Policies															
F. Transportation															
G. Values															

Energy Concepts in SCIS Unit: Populations (Year 3)

Review SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Definition/Properties of Energy Populations Chapters: 3-4	Energy is defined as the ability to cause change. It is the capacity to do work or make somethimg move. The plants and animals in this unit provide students with an operational definition of energy as they grow, move, change, and reproduce.
Review SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Uses of Energy Populations Chapters: 3-4	Students will review the use of light energy for growth as they observe and experiment with their growing plants.
Review SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Energy Conversion Systems Populations Chapters: 3-4	Energy can be converted from one form (such as light or chemical) to another form (such as motion). Plants and animals can be thought of as systems in which this energy conversion takes place. Students will see the results of this energy conversion as their organisms take in light energy and food (chemical energy) and display energy of motion.
Review SCIS Concepts: Food Chain, Food Web *New SCIS Concept: Predator-Prey Energy Concept: Sources of Energy Populations Chapters: 9-14	Students will be observing that the crickets and aphids eat the terrarium plants, and the chameleon eats the crickets. Students can review the food chain concept from "Organisms" by relating food chain to sources of energy. The crickets get their energy by eating the plants; the chameleon gets its energy by eating the crickets. In this way the relationship between predator and prey is seen as an energy relationship. The aquatic food web is another illustration.
Review SCIS Concepts: Food Chain, Food Web *New SCIS Concept: Predator-Prey Energy Concept: Energy Conversion Systems Populations Chapters: 9-14	Energy is converted from one form to another through the food chains. When the cricket eats the plants, some of the chemical energy from the plants is converted to energy of motion and some to heat energy. The cricket's body (as well as the plants and the chameleon's body) can be thought of as energy conversion systems. This unit introduces the concept that some organisms get their energy from plants, and others get their energy from animals.
*SCIS Concept: Community Energy Concept: Society's Dependence on Values Population Chapters: 15-16	The energy needs of a man-dominated community will affect the plant and animal populations in that community. Sometimes the use of the environment for an energy need will decrease a natural population, sometimes it will increase a population. Example: Energy used for transportation may result in exhausts which decrease the population of lichens.

- continued -

Example: Harvesting the larger trees for energy from woodburning may increase the populations of the smaller shrubs, trees, and plants of the forest floor.

Example: Electric generating plants may emit heated water into lakes and rivers that will reduce the populations of some aquatic life.

These examples may raise a value issue with students. They may compare the value of satisfying our energy needs compared to the value of maintaining natural communities.

ENERGY - SCIS MATRIX FOR LIFE SCIENCES
Year 4; Environments

	RELATIONSHIPS				CYCLES						ENVIRONMENTS				
					LIFE			MATERIALS			OPTIMUM RANGE				
	Food Chain	Food Web	Predator Prey	Community	Birth & Growth	Reproduction & Death	Biotic Potential	Decomposers	Oxygen Carbon Dioxide	Water	Habitat	Temperature	Water	Light	Chemical
I. Basic Energy Information															
A. Sources															
B. Definition/Properties					■	■									
C. Forms/States															
D. Uses					■	■						■	■	■	■
E. Conversion					■	■									
F. Conservation															
II. Society's Dependence on Energy															
A. Demands/Needs															
B. Economic															
C. Political Effects															
D. Values															
III. Solutions															
A. Alternative Sources															
1. Types															
2. Values															
B. Conservation															
1. Types															
2. Values															
IV. Minnesota's Energy Issues															
A. Climate/Location												■			
B. Sources Available															
C. Problems															
D. Ownership															
E. Government Policies															
F. Transportation															
G. Values															

Energy Concepts in SCIS Unit: Environments (Year 4)

Review SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Definition/Properties of Energy Environments Chapter: 1	Energy is defined as the ability to cause change. It is the capacity to do work or make something move. The plants and animals in this unit provide students with an operational definition of energy as they grow, move, change, and reproduce.
Review SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Uses of Energy Environments Chapter: 1	Students will review the use of light energy for growth as they observe and experiment with their growing plants.
Review SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Energy Conversion Systems Environments Chapter: 1	Energy can be converted from one form (such as light or chemical) to another form (such as motion). Plants and animals can be thought of as systems in which this energy conversion takes place. Students will see the results of this energy conversion as their organisms take in light energy and food (chemical energy) and as a result display energy of motion.
*SCIS Concept: Optimum range: Temperature, Water, Light, Chemical Energy Concept: Uses of Energy Environmental Chapters: 6-14	Students will discover the significance of maintaining an optimum environmental range for the well being of their plants and animals. We use energy in many ways to insure that such ranges are met for our domesticated plants and animals. Students can easily see how the energy converted by the electric light source maintains the optimum ranges of light and heat. Your class may also apply their experiments with water and chemicals to a discussion of energy uses. Again, energy is often used to maintain optimum ranges in some irrigation systems and through processing chemical fertilizers.
*SCIS Concept: Optimum Range - Temperature Energy Concept: Minnesota Energy Issues - Climate Environment Chapters: 6, 8, 9, 12	Minnesota's climate presents a unique problem in maintaining optimum temperature ranges. This may be experienced directly in your classroom if the organisms have difficulty surviving a cold winter weekend. Relate this experience to the high energy needs Minnesota has in the winter in order to maintain optimum temperature.

ENERGY - SCIS MATRIX FOR LIFE SCIENCES
Year 5; Communities

	RELATIONSHIPS				CYCLES						ENVIRONMENTS				
					LIFE			MATERIALS			OPTIMUM RANGE				
	Food Chain	Food Web	Predator Prey	Community	Birth & Growth	Reproduction & Death	Biotic Potential	Decomposers	Oxygen Carbon Dioxide	Water	Habitat	Temperature	Water	Light	Chemical
I. Basic Energy Information															
A. Sources	●	●	●			●									
B. Definition/Properties					●	●									
C. Forms/States					●										
D. Uses					●	●									
E. Conversion	●	●	●		●	●									
F. Conservation															
II. Society's Dependence on Energy															
A. Demands/Needs															
B. Economic															
C. Political Effects															
D. Values															
III. Solutions															
A. Alternative Sources															
1. Types															
2. Values															
B. Conservation															
1. Types															
2. Values															
IV. Minnesota's Energy Issues															
A. Climate/Location															
B. Sources Available															
C. Problems															
D. Ownership															
E. Government Policies															
F. Transportation															
G. Values															

Energy Concepts in SCIS Unit : Communities (Year 5)

Review SCIS Concept: Birth and Growth (Germination) Energy Concept: States of Energy Communities Chapters: 1-2	A seed is an example of stored or potential energy. Given correct temperature and water, the germination process allows the seed to release its stored energy. This release of energy happens before photosynthesis begins. Students will see the effects of the seed's stored energy being released as they observe the first appearances of roots and stems and the withering of the seeds and cotyledons.
Review SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Definition/Properties of Energy Communities Chapters: 3, 4, 14	Energy is defined as the ability to cause change. It is the capacity to do work or make something move. The plants and animals in this unit provide students with an operational definition of energy as they grow, move, change and reproduce.
Review SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Uses of Energy Communities Chapters: 3, 4, 14	Students will review the use of light energy for growth as they observe and experiment with their growing plants.
Review SCIS Concepts: Food Chain, Food Web, Predatory-Prey Energy Concept: Sources of Energy Communities Chapters: 7, 9, 10	Students can review the food web concept by thinking of their organisms as sources of energy for other living things. The grass is a source of energy for the isopods and crickets; the isopods and crickets are sources of energy for the frogs. In this way the relationship between predator and prey is seen as an energy relationship. Food chain is analogous to energy chain.
Review SCIS Concepts: Growth and Reproduction, Food Chain, Food Web, Predator-Prey Energy Concept: Energy Conversion Systems Communities Chapters: 7, 9, 10	Energy is converted from one form to another through the food chains. When the cricket eats the mustard seeds, stored chemical energy from the seeds is converted to mechanical energy as displayed by the cricket's movement. The animal's body can be thought of as an energy conversion system. Plants also are the conversion systems as they use light energy and food (chemical energy) for growth.
*SCIS Concept: Reproduction Energy Concept: Energy Sources, Renewable & Non-Renewable (Biotic Potential) Communities Chapter: 13	Organic material is an example of a renewable energy source because it is recurring or continuous. Although coal, oil, natural gas and peat originate from organic material, they are non-renewable sources because they take a great deal of time to form and cannot be replenished in human time spans. The reproductive capacity of a plant is important in order to provide a continuous supply of energy. Reproduction sustains the population of trees for woodburning and sustains the population for biomass, such as water lillies or cattails.

ENERGY - SCIS MATRIX FOR LIFE SCIENCES
Year 6; Ecosystems

	RELATIONSHIPS				CYCLES						ENVIRONMENTS				
					LIFE			MATERIALS			OPTIMUM RANGE				
	Food Chain	Food Web	Predator Prey	Community	Birth & Growth	Reproduction & Death	Biotic Potential	Decomposers	Oxygen Carbon Dioxide	Water	Habitat	Temperature	Water	Light	Chemical
I. Basic Energy Information															
A. Sources	○	○	○	○											
B. Definition/Properties					○	○									
C. Forms/States															
D. Uses					○	○									
E. Conversion	○	○	○		○	○						○			○
F. Conservation															
II. Society's Dependence on Energy															
A. Demands/Needs															
B. Economic															
C. Political Effects															
D. Values															
III. Solutions															
A. Alternative Sources															
1. Types				○											
2. Values				○											
B. Conservation															
1. Types															
2. Values															
IV. Minnesota's Energy Issues															
A. Climate/Location															
B. Sources Available															
C. Problems				○											
D. Ownership															
E. Government Policies															
F. Transportation				○											
G. Values				○											

Energy Concepts in SCIS Unit: Ecosystems (Year 6)

Review SCIS Concepts: Birth, Growth, Reproduction Energy Concept: Definition/Properties of Energy Ecosystems Chapters: 1-2	Energy is defined as the ability to cause change. It is the capacity to do work or make something move. The plants and animals in this unit provide students with an operational definition of energy as they grow, move, change and reproduce.
Review SCIS Concept: Birth, Growth, Reproduction Energy Concept: Uses of Energy Ecosystems Chapters: 1-2	Students will review the use of light energy for growth as they observe and experiment with their growing plants.
Review SCIS Concepts: Food Chain, Food Web, Predatory-Prey Energy Concepts: Sources of Energy Ecosystems Chapter: 3	Students can review the food web concept by thinking of their organisms as sources of energy for other living things in their terrarium. The algae is a source of energy for the daphnia, the daphnia is a source of energy for the guppies. In this way the relationship between predator and prey is seen as an energy relationship.
Review SCIS Concepts: Growth, Reproduction, Food Chain, Food Web, Predator-Prey Energy Concepts: Energy Conversion Systems Ecosystems Chapters: 1-3	Energy is converted from one form to another through the food chains. When the cricket eats the grass and clover, chemical energy from the plants is converted to mechanical energy as displayed by the cricket's movement. The animal's body can be thought of as an energy conversion system. Plants also are conversion systems as they use light energy and food (chemical energy) for growth.
*SCIS Concept: Community-Pollutant Energy Concept: Sources of Energy Ecosystems Chapters: 17-21	A pollutant is defined as any substance added to an ecosystem in a quantity that is harmful to organisms. It can be more broadly defined as any unpleasant environmental situation. Energy production affects our surroundings. Students can identify some of the effects current energy production has on the ecosystems they are studying in this unit. Some examples to consider are strip mining of coal, oil spills, and gas explosions.
*SCIS Concept: Community-Pollutant Energy Concept: Alternative Sources Of Energy, Types Ecosystems Chapter: 17-21	Sources of energy differ in their environmental effects. This is true of our newer energy alternatives, as well as of the traditional energy sources. Students could identify how the development of the following alternatives might affect an ecosystem: biomass, wind, solar, tides, geothermal.
*SCIS Concept: Optimum Range - Temperture Energy Concept: Conversion Systems/ Technologies Ecosystems Chapters: 17-21	There is a direct impact on our environment as energy is used. Most energy is processed through a conversion system before we use it. For example: heat energy from burning coal is converted to electricity through the generating plant; or the energy from gasoline combustion is converted to mechanical energy in the automobile.

- continued -

SCIS Unit: Ecosystems (Year 6) Continued

	When energy is changed from one form to another, some energy is lost in the form of by-products, such as heat. Students can identify energy conversion processes which increase the effects this might have on the optimum temperature range of certain organisms, and in turn what effect this could have on the total ecosystem. An example could be the large amount of water required to cool electrical generating plants (coal, oil, gas or nuclear).
*SCIS Concept: Optimum Range-Chemicals Energy Concept: Conversion Systems/ Technologies Ecosystems Chapters: 17-21	Some conversion systems affect the optimum range of chemicals in environment. High temperature power plants, gasoline engines, oil fields and refineries produce nitrogen dioxides and hydrocarbons - all of which contribute to photochemical smog. Lead and carbon monoxide are also emitted by high compression engines. Coal burning furnaces emit sulfur dioxides. The study of the oxygen carbon dioxide cycle will heighten the students' appreciation of the significance of the optimum range and balance of chemicals in the environment. This appreciation will help them better understand the complex problems that arise when energy interacts with environment.
*SCIS Concept: Communities-Pollutant Energy Concept: Minnesota Energy Issues: Transportation of Energy Sources Ecosystems Chapters: 17-21	Minnesota has no traditional energy sources within the state. This necessitates the transportation of oil, coal and gas into the state from Canada, the Near East, and other states. Students can compare the effects that pipelines, tankers, storage tanks, railroads and trucks have on the ecosystem as they transport our energy sources.
*SCIS Concept: Communities-Pollutant Energy Concept: Minnesota Energy Issues: Problems with Sources Ecosystems Chapters: 17-21	Minnesota has extensive peat reserves. Peat can be dried and burned directly or it can be made into synthetic natural gas. Both possibilities are being explored. Students can apply their learnings of ecosystems to the environmental problems that are raised by peat excavation.*
*SCIS Concept: Community Energy Concepts: Possible Solutions: Alternative Sources of Energy - Values, Trade-offs, Minnesota Energy Issues: Values Ecosystems Chapters: 17-21	All of the above sections need to be put in the context of individual and societal values. When students discuss the effects of energy on an ecosystem, it is important that they are encouraged to consider all sides of an issue: the importance of energy in our lives as well as the importance of the environment. Encourage students to seek out all the alternatives and weigh the consequences of each. Many of the issues will result in trade-offs. For example: burning coal may cause increased air pollution, but it may be cheaper than burning gas or oil. Peat gasification may provide Minnesota with a much needed energy source, but its excavation could affect our land and water.

*For further teacher background information on peat as an energy source, consult the following:
Energy Policy and Conservation Report, Minnesota Energy Agency, 1978
Hozza, Dorothy D., "Peat for Man's Sake," The Minnesota Volunteer, Department of Natural Resources, Jan-Feb, 1977.

SCIS Physical Science Concepts

CONCEPTS	SCIS Units					
	MATERIAL OBJECTS Year 1	INTERACTION & SYSTEMS Year 2	SUB-SYSTEMS & VARIABLES Year 3	RELATIVE POSITION & MOTION Year 4	ENERGY SOURCES Year 5	MODELS; ELECTRIC & MAGNETIC Year 6
MATERIAL Properties	○					
Changes	○					
Forms of Matter			△			
INTERACTION Evidence of Interaction		⌓			⬡	⬡
Interaction at a Distance		⌓				⬡
Systems		⌓	△			
Sub-Systems			△			
POSITION & MOTION Relative Position & Motion				□		
Polar & Rectangular Coordinates				□		
ENERGY Energy Sources					⬡	⬡
Energy Receivers					⬡	⬡
Energy Transfer					⬡	⬡
Energy Chain					⬡	⬡
Electricity						⬡
Magnetism						⬡
Scientific Models						⬡

ENERGY - SCIS MATRIX FOR PHYSICAL SCIENCES

SCIS Physical Sciences / Energy	MATERIAL			INTERACTION				POSITION & MOTION		ENERGY						
	Properties	Changes	Forms of Matter	Evidence of Interaction	Interaction at a Distance	Systems	Sub-Systems	Relative Position & Motion	Polar Rectangular Coordinates	Energy Sources	Energy Receivers	Energy Transfer	Energy Chain	Electric	Magnetism	Scientific Models
I. Basic Energy Information																
A. Sources	○									⬡○				◎		
B. Definition/ Properties		○	△	⌓						⬡	⬡	⬡		◎		◎
C. Forms/States				⌓ ⬡	⌓		△	□		⬡	⬡	⬡ ◎		◎		
D. Uses			△								⬡ ◎			◎		
E. Conversion				⌓ ⬡		⌓ △							⬡	◎	⬡	
F. Conservation													⬡	◎		
II. Society Dependence on Energy																
A. Demands/Needs																
B. Economic Effects																
C. Political Effects																
D. Values																
III. Possible Solutions																
A. Alternative Sources																
1. Types									□							
2. Values																
B. Conservation																
1. Types																
2. Values																
IV. Minnesota's Energy Issues																
A. Climate/Location																
B. Sources Available										⬡						
C. Problems with Sources																
D. Ownership																
E. Government Policies																
F. Transportation																
G. Values																

SCIS Units - Physical Sciences

KEY:
- ○ Year 1; Material Objects
- ⌓ Year 2; Interaction and Systems
- △ Year 3; Subsystems and Variables
- □ Year 4; Relative Position and Motion
- ⬡ Year 5; Energy Sources
- ◎ Year 6; Models: Electric and Magnetic Interaction

ENERGY - SCIS MATRIX FOR PHYSICAL SCIENCES

Year 1; Material Objects

SCIS Physical Sciences Energy	MATERIAL			INTERACTION				POSITION & MOTION		ENERGY						
	Properties	Changes	Forms of Matter	Evidence of Interaction	Interaction at a Distance	Systems	Sub-Systems	Relative Position & Motion	Polar Rectangular Coordinates	Energy Sources	Energy Receivers	Energy Transfer	Energy Chain	Electric	Magnetism	Scientific Models
I. Basic Energy Information																
A. Sources	○															
B. Definition/ Properties		○														
C. Forms/States																
D. Uses																
E. Conversion																
F. Conservation																
II. Society Dependence on Energy																
A. Demands/Needs																
B. Economic Effects																
C. Political Effects																
D. Values																
III. Possible Solutions																
A. Alternative Sources																
1. Types																
2. Values																
B. Conservation																
1. Types																
2. Values																
IV. Minnesota's Energy Issues																
A. Climate/Location																
B. Sources Available																
C. Problems with Sources																
D. Ownership																
E. Government Policies																
F. Transportation																
G. Values																

Energy Concepts in SCIS Unit: Material Objects (Year 1)

*SCIS Concept: Properties of Material Objects Energy Concept: Sources of Energy Material Objects Chapters: 7-16	Students identify examples of solids, liquids and gases as objects. This unit does not involve the student directly with energy, but provides the groundwork for later studies on energy sources which are obtainable as solids, liquids and gases. Chapter 13 compares wood in different forms. This will help students better understand our use of wood as a fuel in the form of logs, charcoal, woodchips, or pellets.
*SCIS Concept: Changes in Material Objects Energy Concept: Definition/Properties of Energy Material Objects Chapters: 18-19	Students will observe changes in material objects as they sand balsa wood, grind sugar cubes and rock candy, and melt ice cubes. The unit emphasizes the students' acting upon the objects. In each example, energy is involved in making the change in the object. Since energy is defined as the ability to cause changes, students will be experiencing an operational definition of energy.

ENERGY - SCIS MATRIX FOR PHYSICAL SCIENCES

Year 2; Interactions and Systems

SCIS Physical Sciences Energy	MATERIAL			INTERACTION				POSITION & MOTION		ENERGY						
	Properties	Changes	Forms of Matter	Evidence of Interaction	Interaction at a Distance	Systems	Sub-Systems	Relative Position & Motion	Polar Rectangular Coordinates	Energy Sources	Energy Receivers	Energy Transfer	Energy Chain	Electric	Magnetism	Scientific Models
I. Basic Energy Information																
A. Sources																
B. Definition/ Properties				⌓												
C. Forms/States				⌓	⌓											
D. Uses																
E. Conversion				⌓		⌓										
F. Conservation																
II. Society Dependence on Energy																
A. Demands/Needs																
B. Economic Effects																
C. Political Effects																
D. Values																
III. Possible Solutions																
A. Alternative Sources																
1. Types																
2. Values																
B. Conservation																
1. Types																
2. Values																
IV. Minnesota's Energy Issues																
A. Climate/Location																
B. Sources Available																
C. Problems with Sources																
D. Ownership																
E. Government Policies																
F. Transportation																
G. Values																

Energy Concepts in SCIS Unit: Interaction & Systems (2)

*SCIS Concept: Evidence of Interaction Energy Concept: Definition/Properties of Energy Interaction & Systems Chapters: 4-7	Energy is the ability to cause change; the capacity to do work or make something move. Although students are not referring to their activities as energy experiments, they are experiencing an operational definition of energy. Students observe the changes that result from light (a form of energy) interacting with Ozalid paper or photographic paper. They are asked to draw a picture of the sun (heat energy) interacting with an ice cream cone. The phrases "evidence of interaction" and "evidence of energy" both refer to observed changes among interacting objects.
*SCIS Concept: Interaction:Systems Energy Concept: Conversion Systems/ Technologies Interaction & Systems Chapters: 8-10, 12-13	The concept of "system" is preliminary to understanding energy conversion systems. Students work with an energy conversion system in Chapter 8 that consists of a light bulb, wire and battery. This system is made up of related parts, the relation stemming from the interaction between the parts so that electrical energy will be converted to light. Students will explore the transfer of mechanical energy when they do the activities with pulleys.
*SCIS Concept: Interaction at a Distance Energy Concept: Forms of Energy Interaction & Systems Chapters: 16-17	Students will explore energy in the forms of static electricity, light and sound. Energy can be a difficult concept for primary students to understand because it is so abstract. It is only the evidence of its interaction with other objects that provides concrete examples of its existence. Often energy falls into the category of "interaction at a distance." The experiences provided in these chapters will help students better understand the abstractness of energy. You may find your students talking about magnetic force as if it were energy. Magnetism by itself is not an energy source, but it is a helpful force in converting mechanical energy to electrical energy, or electrical to mechanical (as in motors and generators). Students at this age should not be expected to distinguish between magnetic force and energy. Scientists, in fact, are often confused about the real nature of magnetism and its relationship to energy. However, students will need these beginning experiences with magnetism to better understand energy conversion systems and technologies.
*SCIS Concept: Evidence of Interaction Energy Concept: Forms of Energy and Energy Conversion Systems Interaction & Systems Chapters: 18-20	Students experiment with electrical energy as they construct electric circuits, explore open and closed circuits and attach an electrical system to a pulley system.

ENERGY - SCIS MATRIX FOR PHYSICAL SCIENCES

Year 3; Subsystems and Variables

SCIS Physical Sciences Energy	MATERIAL			INTERACTION				POSITION & MOTION		ENERGY						
	Properties	Changes	Forms of Matter	Evidence of Interaction	Interaction at a Distance	Systems	Sub-Systems	Relative Position & Motion	Polar Rectangular Coordinates	Energy Sources	Energy Receivers	Energy Transfer	Energy Chain	Electric	Magnetism	Scientific Models
I. Basic Energy Information																
A. Sources																
B. Definition/ Properties		△					△									
C. Forms/States																
D. Uses		△				△										
E. Conversion																
F. Conservation																
II. Society Dependence on Energy																
A. Demands/Needs																
B. Economic Effects																
C. Political Effects																
D. Values																
III. Possible Solutions																
A. Alternative Sources																
1. Types																
2. Values																
B. Conservation																
1. Types																
2. Values																
IV. Minnesota's Energy Issues																
A. Climate/Location																
B. Sources Available																
C. Problems with Sources																
D. Ownership																
E. Government Policies																
F. Transportation																
G. Values																

Energy Concepts in SCIS Unit: Sub-Systems and Variables (Year 3)

Review SCIS Concept: Interactions & Systems Energy Concept: Conversion Systems/ Technologies Sub-Systems & Variables Chapter: 1	The concept of "system" is preliminary to understanding energy conversion systems. Students review an energy conversion system in this chapter that consists of a light bulb, wire and battery. This system is made up of related parts, the relation stemming from the interaction between the parts so that electrical energy will be converted to light.
*SCIS Concept: Interaction/Sub-Systems Energy Concept: Forms of Energy (Electrical) Sub-Systems & Variables Chapter: 5	Students gain additional experience with electric circuits as they identify sub-systems on the electric circuit puzzles.
*SCIS Concept: Forms of Matter Energy Concept: Uses of Energy Sub-Systems & Variables Chapters: 11-15	Energy is involved when matter changes forms between gas, liquid or solid. Students can identify how energy was used in their experiments with water, ice and Freon. Students will also experience the transfer of heat energy. Heat will transfer from the Freon-bag system to the ice-bag system in Chapter 12.
*SCIS Concept: Forms of Matter Energy Concept: Definition/Properties of Energy Sub-Systems & Variables Chapters: 13, 15	Energy can be measured. Students will use thermometers to measure the quantity of heat energy.
*SCIS Concept: Sub-Systems Energy Concept: Forms of Energy (Mechanical) Sub-Systems & Variables Chapters: 16-19	Whirlybirds provide students with an opportunity to discover the workings of mechanical energy. A starter system furnishes the energy to start the whirlybird in motion. This starter system may be a child's hand, a rubber band or breath blowing on the system. It illustrates the transfer of energy from one system to another. Students will also experience that some energy is used to overcome friction. Their graphs may show that the initial energy from the starter system resulted in more turns once they reduced the friction.

ENERGY - SCIS MATRIX FOR PHYSICAL SCIENCES

Year 4; Relative Position and Motion

SCIS Physical Sciences Energy	MATERIAL			INTERACTION				POSITION & MOTION		ENERGY						
	Properties	Changes	Forms of Matter	Evidence of Interaction	Interaction at a Distance	Systems	Sub-Systems	Relative Position & Motion	Polar Rectangular Coordinates	Energy Sources	Energy Receivers	Energy Transfer	Energy Chain	Electric	Magnetism	Scientific Models
I. Basic Energy Information																
A. Sources																
B. Definition/ Properties																
C. Forms/States								☐								
D. Uses																
E. Conversion																
F. Conservation																
II. Society Dependence on Energy																
A. Demands/Needs																
B. Economic Effects																
C. Political Effects																
D. Values																
III. Possible Solutions																
A. Alternative Sources																
1. Types									☐							
2. Values																
B. Conservation																
1. Types																
2. Values																
IV. Minnesota's Energy Issues																
A. Climate/Location																
B. Sources Available																
C. Problems with Sources																
D. Ownership																
E. Government Policies																
F. Transportation																
G. Values																

Energy Concepts in SCIS Unit: Relative Position and Motion (Year 4)

*SCIS Concept: Relative Motion Energy Concept: Energy Forms (Motion) Relative-Position & Motion Chapters: 10-14	Force is required to produce an acceleration in the motion of a body. As students experiment with the rolling spheres, they discover variables that affect the behavior of a rolling sphere. The energy of motion is also experienced as they observe the tracks of collisions.
*SCIS Concept: Polar Coordinates Energy Concept: Alternative Sources of Energy - Solar Relative-Position & Motion Chapters: 15-18	The basic information provided here will assist students in future studies of solar energy. They will be better equipped to understand the angle of the sun's rays in different latitudes of the world, as well as the angles of reflection of the sun's rays off water or snow.

ENERGY - SCIS MATRIX FOR PHYSICAL SCIENCES

Year 5; Energy Sources

SCIS Physical Sciences Energy	MATERIAL			INTERACTION				POSITION & MOTION		ENERGY						
	Properties	Changes	Forms of Matter	Evidence of Interaction	Interaction at a Distance	Systems	Sub-Systems	Relative Position & Motion	Polar Rectangular Coordinates	Energy Sources	Energy Receivers	Energy Transfer	Energy Chain	Electric	Magnetism	Scientific Models
I. Basic Energy Information																
A. Sources										⬡						
B. Definition/ Properties										⬡	⬡	⬡				
C. Forms/States										⬡	⬡	⬡				
D. Uses											⬡					
E. Conversion													⬡			
F. Conservation																
II. Society Dependence on Energy																
A. Demands/Needs																
B. Economic Effects																
C. Political Effects																
D. Values																
III. Possible Solutions																
A. Alternative Sources																
1. Types																
2. Values																
B. Conservation																
1. Types																
2. Values																
IV. Minnesota's Energy Issues																
A. Climate/Location																
B. Sources Available										⬡						
C. Problems with Sources																
D. Ownership																
E. Government Policies																
F. Transportation																
G. Values																

Energy Concepts in SCIS Unit: Energy Sources (Year 5)

*SCIS Concept: Energy Sources Energy Concept: Energy Sources; Minnesota Energy Sources Energy Sources Chapter: 5	As students are identifying energy sources, encourage them to identify specific sources of energy found in Minnesota as well as sources from outside the state.
*SCIS Concept: Energy Receiver Energy Concept: Uses of Energy Energy Sources Chapter: 5	The process of identifying energy receivers and evidence of energy transfer is very similar to listing our uses for energy. For example: a furnace receives oil, and the evidence of transfer is that our home is heated.
*SCIS Concept: Energy Transfer, Sources and Receivers Energy Concept: Definition/Properties of Energy Energy Sources Chapters: 5-6	Energy can be transferred from one object to another. This process in which a form of energy is exchanged between objects is designated as energy transfer. (In the process of energy conversion one form of energy is changed to another form.)
*SCIS Concept: Energy Chain Energy Concept: Conversion System/ Technologies; Energy Conservation Energy Sources Chapter: 7	Sometimes when energy is transferred from one object to another, it changes form. It can be converted from motion to heat as in the examples of friction, or as in the paper clip experiment in Chapter 7. These concepts of energy chain and energy conversion (energy that is changed to other forms during energy transfer) are very important to understanding larger energy issues. Energy efficiency ratios on machines and appliances are based on how much energy received by an object is actually converted to the desired form. This leads directly to the subject of energy conservation; avoiding as much loss of usable energy as possible.
*SCIS Concept: Energy Transfer Energy Concept: Definition/Properties of Energy; Forms of Energy (Thermal) Energy Sources Chapters: 8-10	Energy can be measured. Thermometers measure how much energy can be gained when objects are heated and how much energy is given off when objects are cooled. Thermal energy is exchanged between systems of differing temperatures. This is the basic concept behind many machines and appliances, such as refrigerators, stoves, heat exchangers, and radiators.
*SCIS Concept: Energy Transfer, Sources and Receivers Energy Concept: Forms of Energy (Motion) Energy Sources Chapter: 11-14	"Stopper poppers" and "spheres and sliders" are two systems in which the students explore the transfer of kinetic energy (energy of motion). Energy is transferred from the syringe to the stopper as energy of motion. Some energy is converted to heat through friction as it strikes the ground. The sphere transfers its energy to the slider which results in friction. This process converts the energy to heat.

- continued -

SCIS Unit:Energy Sources (Year 5) Continued

*SCIS Concept: Energy Transfer, Sources, and Receivers Energy Concept: Forms of Energy (Thermal) Energy Sources Chapters: 15-17	These chapters encourage students to develop more complex methods of measuring thermal energy transfer through a series of ice cube experiments.
*SCIS Concept: Energy Transfer, Sources and Receivers Energy Concept: Forms of Energy (Chemical) Energy Sources Chapter: 18	This chapter is an introduction to chemical energy. Students experiment with a chemical system that is a source of energy, and another chemical system that is an energy receiver.

ENERGY - SCIS MATRIX FOR PHYSICAL SCIENCES

Year 6; Models: Electric and Magnetic Interactions

SCIS Physical Sciences Energy	MATERIAL			INTERACTION				POSITION & MOTION		ENERGY						
	Properties	Changes	Forms of Matter	Evidence of Interaction	Interaction at a Distance	Systems	Sub-Systems	Relative Position & Motion	Polar Rectangular Coordinates	Energy Sources	Energy Receivers	Energy Transfer	Energy Chain	Electric	Magnetism	Scientific Models
I. Basic Energy Information																
A. Sources										○				○		
B. Definition/ Properties														○		○
C. Forms/States				○								○		○		
D. Uses				○							○			○		
E. Conversion														○	○	
F. Conservation														○		
II. Society Dependence on Energy																
A. Demands/Needs																
B. Economic Effects																
C. Political Effects																
D. Values																
III. Possible Solutions																
A. Alternative Sources																
1. Types																
2. Values																
B. Conservation																
1. Types																
2. Values																
IV. Minnesota's Energy Issues																
A. Climate/Location																
B. Sources Available																
C. Problems with Sources																
D. Ownership																
E. Government Policies																
F. Transportation																
G. Values																

Energy Concepts in SCIS Unit: Models: Electric & Magnetic Interactions (Year 6)

Review SCIS Concept: Energy Sources, Receivers, Energy Transfer, Evidence Of Interaction Energy Concepts: Sources of Energy; Uses of Energy, Forms of Energy (Electrical, Chemical) Models Chapters: 1-4	Students review these concepts by constructing open and closed circuits and making energy sources similar to batteries. The battery is identified as the energy source; the bulb is the energy receiver, and energy transfer is from the battery to the bulb. The evidence of interaction is observed when the bulb lights. This entire process illustrates an operational definition of energy: the ability to cause change; the capacity to do work or make something move.
*SCIS Concept: Scientific Models; Electricity Energy Concept: Definition/Properties of Energy (Electrical) Model Chapters: 5-7, 12-14	The concept of scientific-model building is especially significant in the field of energy since energy is a very abstract phenomenon. Many of our ideas about energy are just that - ideas, theories. Therefore, a scientific model is often used to help explain how scientists think energy works. Electricity is one energy form that is convenient for intermediate students to use for creating a model of energy transfer. Their task is to describe a mental image that helps explain how an electrical system functions.
*SCIS Concept: Magnetism Energy Concept: Conversion Systems/ Technologies Models Chapters: 8-11	You may find your students talking about magnetic force as if it were energy. Magnetism by itself is not an energy source, but it is a helpful force in converting mechanical energy to electrical energy, or electrical to mechanical (as in motors and generators). Students at this age should not be expected to distinguish between magnetic force and energy. Scientists, in fact, are often confused about the real nature of magnetism and its relationship to energy. The SCIS investigations with magnets provide students with direct experience with mechanical force in the form of a force field near each magnet. This is an example of interaction-at-a-distance. Students then combine their learnings of magnets and electricity as they construct electro-magnets.
*SCIS Concept: Electricity Energy Concept: Forms of Energy; Uses of Energy; Conversion Systems/ Technologies Models Chapter: 15	Electrical energy is converted to both heat energy and light energy as it is transfered to the nichrome wire and light bulb.
*SCIS Concept: Electricity Energy Concept: Definition/Properties of Energy Models Chapter: 16	Energy can be measured, and here students construct an electro-scale to measure electricity in a circuit. This culminating activity draws upon all previous learnings about energy in order to extend a scientific model of electricity.

- continued -

SCIS Unit: Models (Year 6) Continued

*SCIS Concept: Electricity (Batteries)
Energy Concept: Conservation; Energy Sources
Models Chapters: 17-18

When students test for endurance of batteries, they will discover that under certain conditions energy is converted to forms that are no longer usable to them. The battery is "dead" when the energy has been removed from it and converted to low temperature heat which is no longer useful.

Students might experiment with different variables to explore the life of a battery being used to light a bulb. Similar endurance investigations can be done with the bleach energy source.